

**X-540-68-220**

# **DUAL FREQUENCY (20.0-19.9 kHz) VLF DATA**

**C. H. LOONEY**

N72-12084 (NASA-TM-X-65755) DUAL FREQUENCY  
(20.0-19.9 kHz) VLF DATA C.H. Looney  
(NASA) Jun. 968 21 P CSCL 20N

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(CATEGORY)

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**JUNE 1968**



**GODDARD SPACE FLIGHT CENTER  
GREENBELT, MARYLAND**

The columns titled "5-Day Average" are the averages of the daily measurements for the period starting two days before and ending two days after the date of entry. Figure 1 is a plot of the 20.0/19.9 kHz data for 1967. Figure 2 is a plot of that data for 1966. The heavy lines at -9.4 and -9.6 microseconds outline the area corresponding to a coarse differential time between the GSFC clock and WWVL, as received, of 161 cycles of the 20 kHz transmission or 8,050 microseconds.

The GSFC clock was synchronized with the NBS clock operated in the NBS Boulder Laboratories, by means of portable clock measurements. The difference between GSFC clock time and WWVL time, as received, is therefore very nearly equal to the VLF propagation time. This propagation time has been calculated by various methods, and ranges from 8,043 microseconds for the simplest approach to 8,061 microseconds using techniques described by Wait and Spies.<sup>4</sup>

The "Month Average" is the average of all daily measurements made during that calendar month. Figure 3 is a plot of this data for 1967, and Figure 4 is a plot of the data for 1966. Crosshatched areas outline permissible phase variations corresponding to complete ambiguity resolution and resolution to within three cycles or  $\pm 50$  microseconds ambiguity. Figure 5 is a plot of the five-day average 20.0 kHz data for 1967, and Figure 6 is a plot of that data for 1966. These plots indicate the ease with which frequency differences of only a few parts in  $10^{12}$  can be detected.

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<sup>4</sup> J. R. Wait and K. P. Spies, "Characteristics of the Earth Ionosphere Waveguide for VLF Waves", NBS Technical Note No. 300, December 30, 1964.

## DUAL FREQUENCY (20.0 - 19.9 kHz) VLF DATA

Data is now available from 24 months of operation of radio station WWVL, transmitting 20.0 kHz and 19.9 kHz. The 20.0 kHz signal is controlled by the Boulder Laboratories of NBS so that a particular positively-sloped zero crossing is always synchronous with the NBS master clock to within 1.0 microsecond. The 19.9 kHz transmission is also controlled so that a particular positively-sloped zero crossing is synchronous with a particular positively-sloped zero crossing of the 20.0 kHz transmission to within 1.0 microsecond. Daily measurements of the 20.0 and 19.9 kHz transmissions are available from NBS<sup>1,2</sup> and can be used to remove certain systematic variations so that the 19.9 kHz and 20.0 kHz differential phase angle as transmitted can be known to less than 0.2 microsecond.

The instrumentation at GSFC uses a Hewlett-Packard cesium-beam frequency standard, two Tracor VLF receivers and a Tracor VLF calibrator. The H-P cesium standard was measured periodically against two Varian hydrogen masers and is known to have a frequency constant to within a few parts in  $10^{12}$ .

Tables 1 through 12 contain daily measurements of the 20.0 kHz and 20.0/19.9 kHz signal phase angles corrected in accordance with the NBS measurements. The 20.0/19.9 kHz data is a function of the phase angle of the 100 Hz information inherent in the 20.0/19.9 transmissions. This data can be used to resolve the 50 microsecond ambiguity inherent in 20.0 kHz single frequency transmissions.<sup>3</sup>

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<sup>1</sup> 20.0 kHz data is in "Time and Frequency Services Bulletin", Frequency Time Broadcast Services Section, Time and Frequency Division, NBS, Boulder, Colorado, 80302, published monthly.

<sup>2</sup> 19.9 kHz data is available from Section 253.04, Frequency Time Broadcast Services Section, Time and Frequency Division, NBS, Boulder, Colorado, 80302.

<sup>3</sup> C. H. Looney and L. Fey, "A Dual Frequency VLF Timing System", IEEE Transactions on Instrumentation and Measurement, Vol. IM-16, December 1966.

WWVL 20.0/19.9 kHz DIFFERENTIAL PHASE ANGLE  
RECEIVED AT GSFC VERSUS GSFC CESIUM CLOCK  
5 DAY AVERAGES

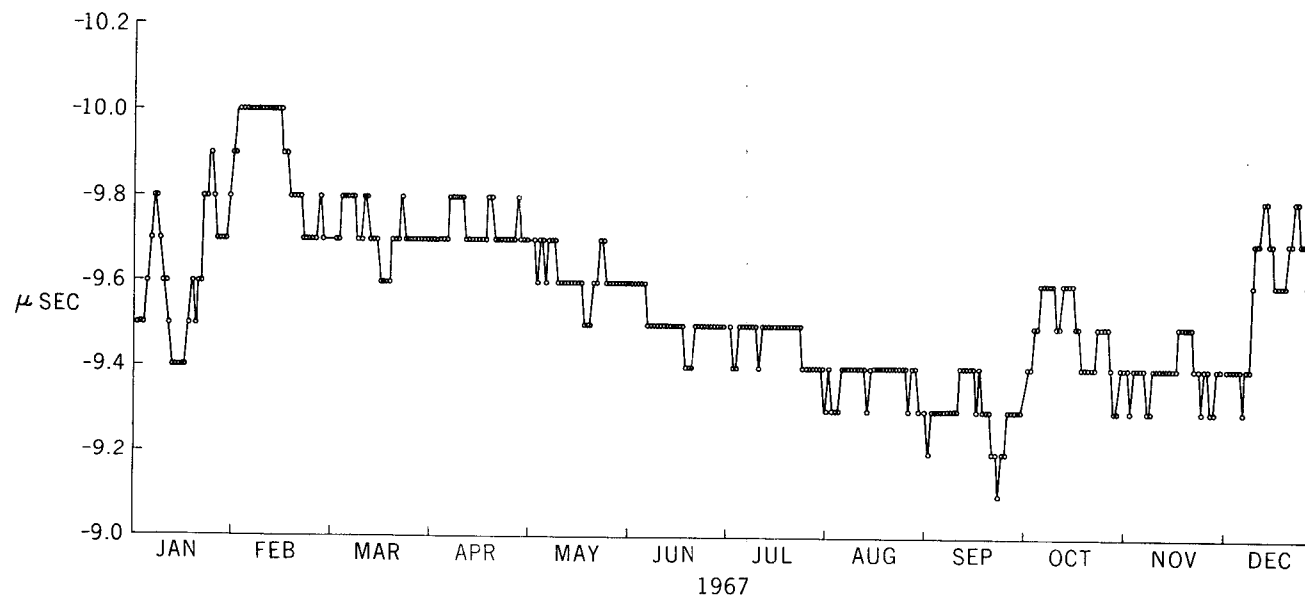


FIGURE 1

# 20.0/19.9 (5 DAY AVERAGE) FOR 1966

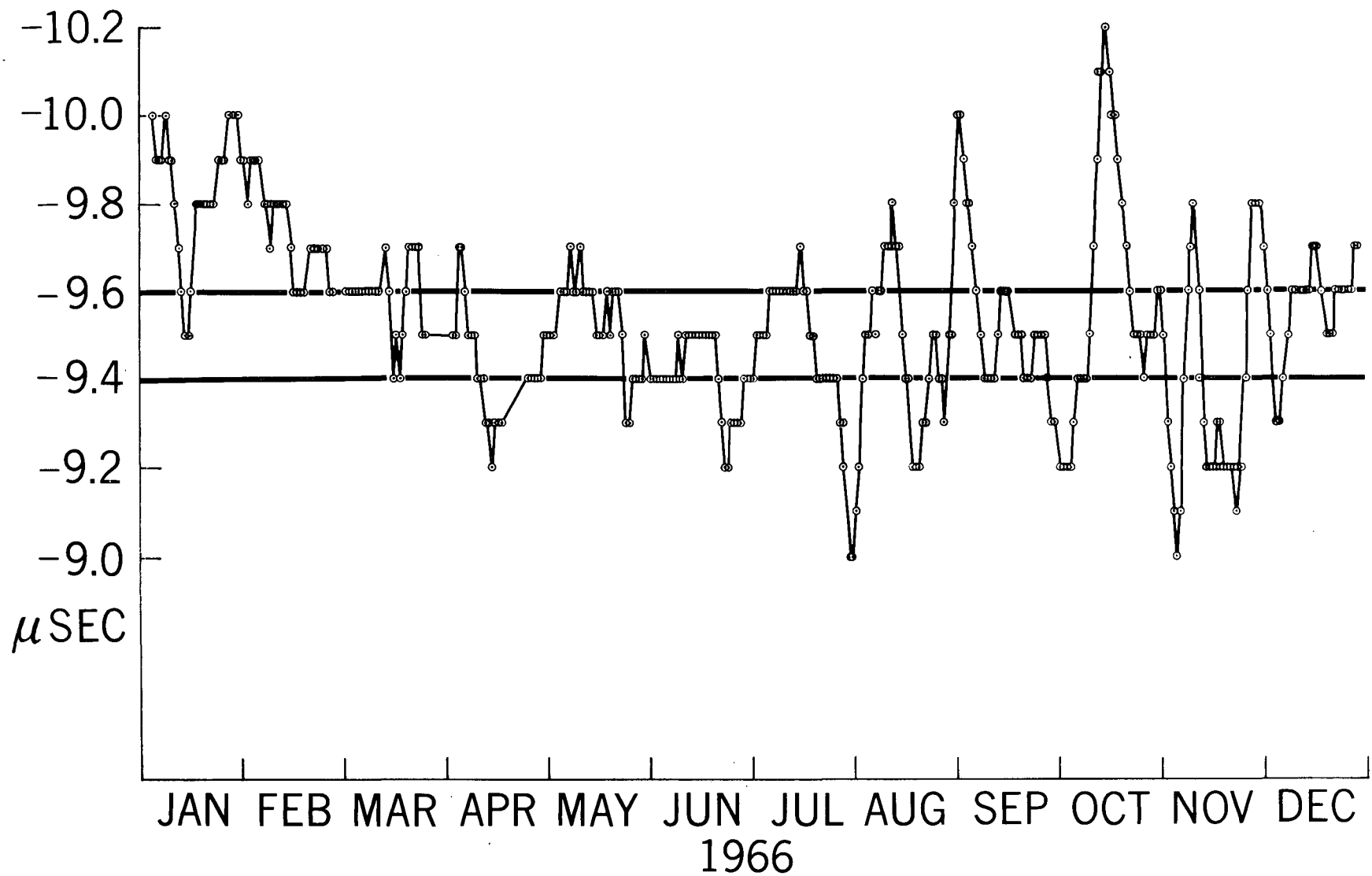


FIGURE 2

# WWVL 20.0/19.9 kHz DIFFERENTIAL PHASE ANGLES RECEIVED AT GSFC VERSUS GSFC CESIUM CLOCK

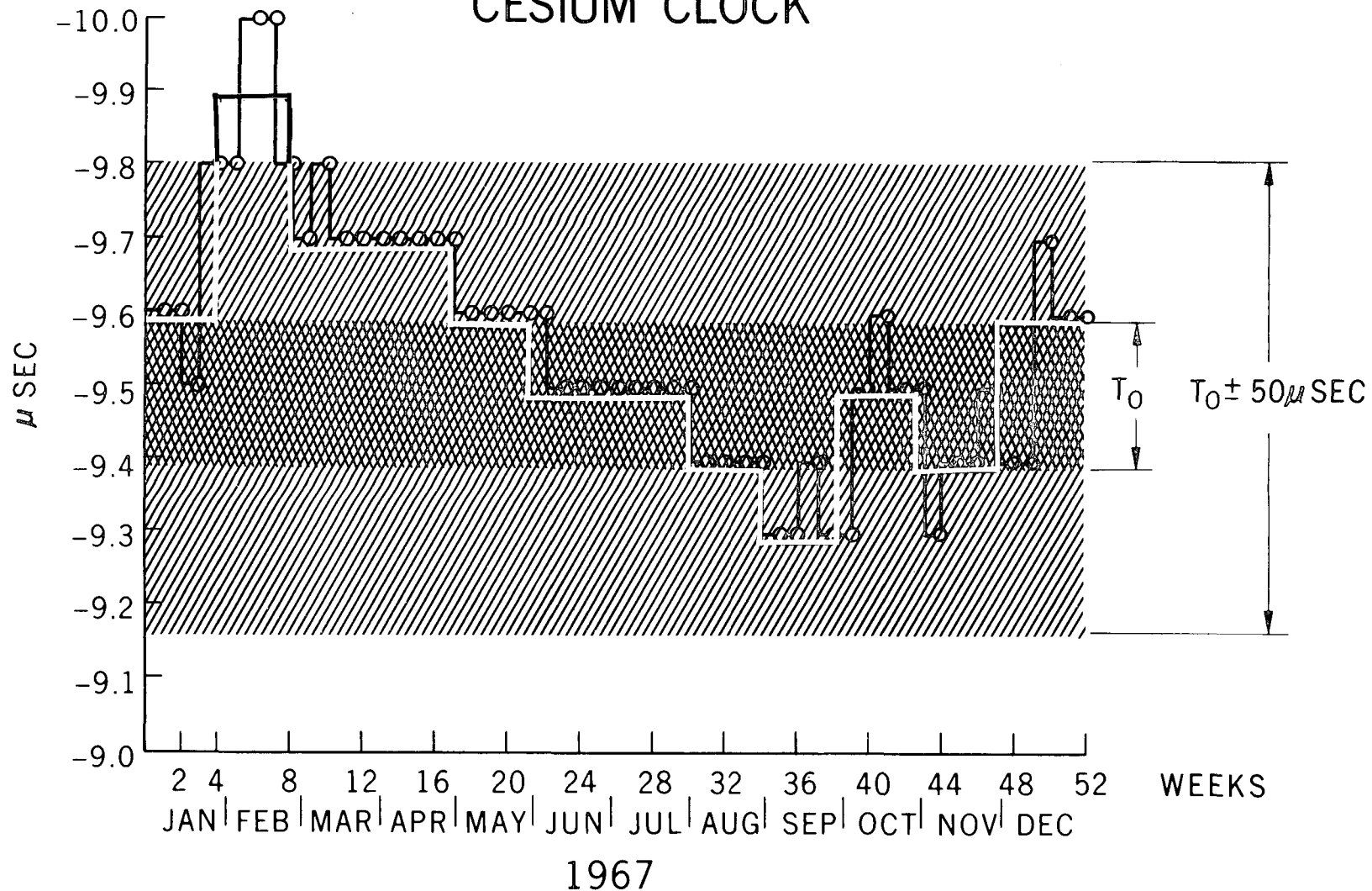


FIGURE 3

# 20.0/19.9 WEEKLY & MONTHLY AVERAGES

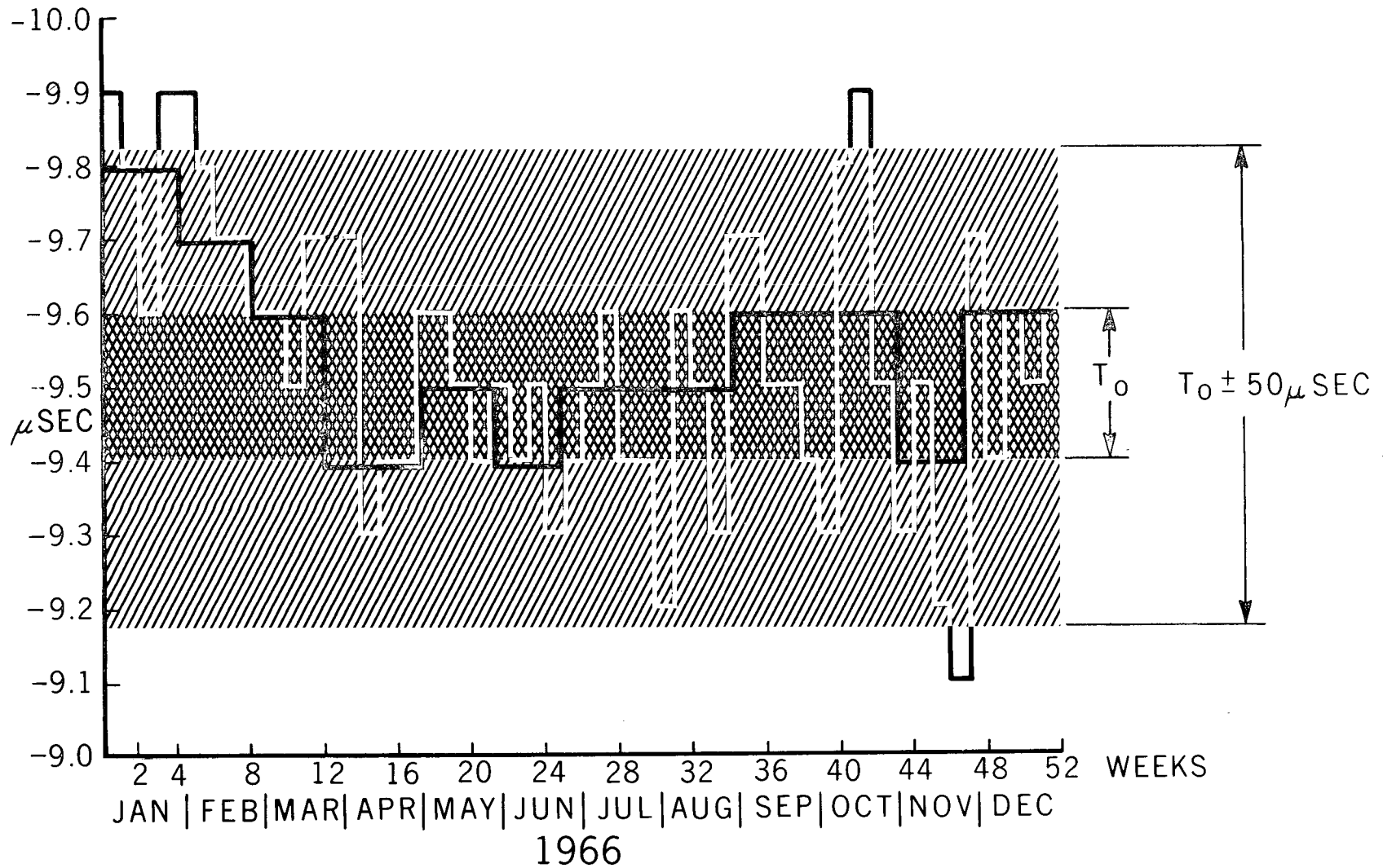


FIGURE 4

WWVL 20 kHz PHASE ANGLE  
RECEIVED AT GSFC VERSUS GSFC CESIUM CLOCK  
5 DAY AVERAGES



FIGURE 5



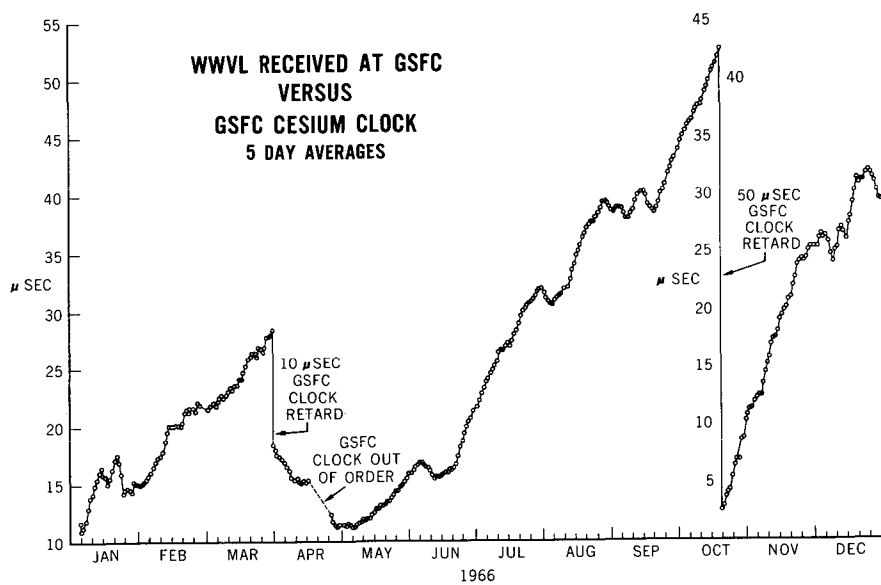


FIGURE 6

VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
January	1	29.3	29.6	-9.1	-9.5
	2	29.4	29.6	-9.1	-9.5
	3	30.0	29.7	-9.7	-9.5
	4	29.6	29.8	-9.8	-9.6
	5	30.0	30.0	-9.7	-9.7
	6	30.0	29.8	-9.9	-9.8
	7	30.2	30.4	-9.7	-9.8
	8	29.4	31.2	-9.9	-9.7
	9	32.2	31.9	-9.7	-9.6
	10	34.2	32.6	-9.5	-9.6
	11	33.4	33.6	-9.4	-9.5
	12	33.7	34.4	-9.6	-9.4
	13	34.7	34.5	-9.4	-9.4
	14	35.8	34.1	-9.2	-9.4
	15	34.7	33.7	-9.3	-9.4
	16	31.6	32.9	-9.6	-9.4
	17	31.6	32.0	-9.3	-9.5
	18	30.6	31.5	-9.5	-9.6
	19	31.3	31.5	-9.7	-9.5
	20	32.3	31.6	-9.7	-9.6
	21	31.7	31.9	--	-9.6
	22	32.2	32.0	-10.0	-9.8
	23	32.1	31.7	-9.8	-9.8
	24	31.7	31.5	-9.8	-9.9
	25	30.8	31.4	-9.8	-9.8
	26	30.8	31.1	-9.9	-9.7
	27	31.4	31.8	-9.5	-9.7
	28	30.7	32.4	-9.4	-9.7
	29	35.2	32.8	-9.8	-9.7
	30	34.0	--	-9.9	-9.8
	31	32.7	--	-9.9	-9.9

-9.6 Monthly Average  
0.25 Noise, rms

TABLE 1

# VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
February	1	32.6	32.7	-10.0	-9.9
	2	31.7	31.9	-9.9	-10.0
	3	32.4	32.0	-9.9	-10.0
	4	29.9	31.1	-10.2	-10.0
	5	33.2	30.8	-10.0	-10.0
	6	28.1	29.8	-9.8	-10.0
	7	30.2	29.1	-10.0	-10.0
	8	27.4	27.6	-9.9	-10.0
	9	26.8	26.8	-10.1	-10.0
	10	25.7	25.9	-10.0	-10.0
	11	24.1	25.0	-10.1	-10.0
	12	25.4	24.4	-9.8	-10.0
	13	22.8	24.2	-10.1	-10.0
	14	23.9	24.7	-10.1	-10.0
	15	25.0	24.3	-10.0	-10.0
	16	26.2	24.3	-9.8	-9.9
	17	23.8	25.0	-9.9	-9.9
	18	22.8	25.3	-9.8	-9.8
	19	27.0	24.6	-9.9	-9.8
	20	26.8	23.1	--	-9.8
	21	22.4	22.3	-9.6	-9.8
	22	17.5	20.1	-9.9	-9.7
	23	17.6	17.6	-9.6	-9.7
	24	16.0	16.3	-9.5	-9.7
	25	14.6	15.6	-9.7	-9.7
	26	15.8	14.5	-9.7	-9.7
	27	13.8	13.7	-9.9	-9.8
	28	12.5	13.2	-9.6	-9.7

-9.9 Monthly Average  
.17 Noise, rms

TABLE 2

## VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
March	1	11.8	12.5	-9.9	-9.7
	2	11.7	11.9	-9.5	-9.7
	3	11.9	11.7	-9.8	-9.8
	4	11.7	11.2	-9.5	-9.8
	5	11.5	11.3	-10.3	-9.8
	6	9.3	11.3	-9.8	-9.8
	7	12.0	11.4	-9.6	-9.8
	8	12.2	11.5	-9.7	-9.7
	9	12.1	11.7	-9.7	-9.7
	10	11.7	11.3	-9.6	-9.8
	11	10.7	11.3	-9.9	-9.8
	12	9.7	11.6	-9.9	-9.7
	13	12.3	11.9	-9.8	-9.7
	14	13.4	12.2	-9.5	-9.7
	15	13.3	12.5	-9.6	-9.6
	16	12.1	12.5	-9.6	-9.6
	17	11.3	11.9	-9.6	-9.6
	18	12.2	11.0	-9.6	-9.6
	19	10.6	10.8	-9.5	-9.7
	20	9.0	10.8	-9.9	-9.7
	21	10.9	10.6	-9.8	-9.7
	22	11.5	10.9	-9.7	-9.8
	23	11.1	11.3	-9.8	-9.7
	24	13.1	12.0	-9.7	-9.7
	25	11.1	12.4	-9.6	-9.7
	26	14.1	12.5	-9.8	-9.7
	27	12.5	12.0	-9.7	-9.7
	28	11.5	12.0	-9.7	-9.7
	29	10.6	11.5	-9.8	-9.7
	30	11.5	11.5	-9.6	-9.7
	31	11.3	11.6	-9.7	-9.7

-9.7 Monthly Average  
.13 Noise, rms

TABLE 3

## VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
April	1	12.8	11.9	-9.8	-9.7
	2	11.7	12.0	-9.6	-9.7
	3	12.1	12.2	-9.7	-9.7
	4	12.0	12.2	-9.6	-9.7
	5	12.4	12.3	-9.8	-9.7
	6	12.7	12.5	-9.8	-9.8
	7	12.4	12.7	-9.8	-9.8
	8	13.1	13.1	-9.9	-9.8
	9	13.1	13.7	-9.8	-9.8
	10	14.2	14.3	-9.7	-9.8
	11	15.5	14.9	-9.7	-9.7
	12	15.8	15.6	-9.8	-9.7
	13	16.2	16.1	-9.7	-9.7
	14	16.4	16.5	-9.5	-9.7
	15	16.7	16.6	-9.6	-9.7
	16	17.4	16.4	-9.7	-9.7
	17	16.1	16.5	-9.9	-9.7
	18	15.5	16.4	-9.7	-9.8
	19	16.7	16.3	-9.7	-9.8
	20	16.6	16.4	-9.8	-9.7
	21	16.4	16.3	-9.7	-9.7
	22	16.8	16.1	-9.8	-9.7
	23	15.1	16.0	-9.7	-9.7
	24	15.8	15.8	-9.6	-9.7
	25	15.9	15.1	-9.6	-9.7
	26	14.5	14.9	-9.8	-9.7
	27	14.4	14.2	-9.8	-9.8
	28	13.0	13.7	-9.9	-9.7
	29	13.3	13.4	-9.7	-9.7
	30	13.3	13.2	-9.5	-9.7

-9.7 Monthly Average  
0.11 Noise, rms

TABLE 4

VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
May	1	13.1	13.0	-9.8	-9.7
	2	13.4	13.0	-9.7	-9.6
	3	11.9	12.9	-9.6	-9.7
	4	13.1	12.6	-9.6	-9.7
	5	12.9	12.3	-9.6	-9.6
	6	11.7	12.4	-9.8	-9.7
	7	11.9	12.4	-9.6	-9.7
	8	12.5	12.3	-9.7	-9.7
	9	13.0	12.4	-9.5	-9.6
	10	12.2	12.5	-9.7	-9.6
	11	12.4	12.3	-9.6	-9.6
	12	12.2	12.0	-9.6	-9.6
	13	11.7	12.0	-9.6	-9.6
	14	11.7	11.9	--	-9.6
	15	11.8	11.8	-9.7	-9.6
	16	11.9	11.8	-9.4	-9.6
	17	11.7	11.8	-9.5	-9.5
	18	12.0	11.8	-9.6	-9.5
	19	11.6	11.8	-9.5	-9.5
	20	--	11.6	--	-9.6
	21	--	10.9	--	-9.6
	22	10.1	10.7	-9.6	-9.7
	23	11.0	10.4	-9.7	-9.7
	24	10.9	10.2	-9.7	-9.6
	25	9.6	10.3	-9.7	-9.6
	26	9.6	10.0	-9.5	-9.6
	27	--	9.6	--	-9.6
	28	--	9.6	--	-9.6
	29	9.7	9.2	-9.5	-9.6
	30	9.6	8.7	-9.7	-9.6
	31	8.4	8.2	-9.6	-9.6
					-9.6 Monthly Average
					0.1 Noise, rms

TABLE 5

VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
June	1	7.2	7.9	-9.6	-9.6
	2	6.3	7.6	-9.6	-9.6
	3	7.9	7.6	-9.7	-9.6
	4	8.3	7.9	-9.5	-9.6
	5	8.5	8.6	-9.6	-9.6
	6	8.4	9.2	-9.5	-9.5
	7	9.8	9.6	-9.6	-9.5
	8	10.9	10.2	-9.5	-9.5
	9	10.3	10.8	-9.5	-9.5
	10	11.5	11.0	-9.5	-9.5
	11	11.4	11.1	--	-9.5
	12	11.1	11.1	-9.5	-9.5
	13	11.3	10.9	-9.4	-9.5
	14	10.2	10.7	-9.5	-9.5
	15	10.6	10.7	-9.6	-9.5
	16	10.6	10.6	-9.5	-9.5
	17	10.8	10.5	-9.4	-9.5
	18	10.2	10.6	--	-9.4
	19	10.4	10.6	-9.4	-9.4
	20	11.1	10.5	-9.4	-9.4
	21	10.3	10.5	-9.5	-9.5
	22	10.4	10.5	-9.5	-9.5
	23	10.5	10.3	-9.5	-9.5
	24	10.2	10.3	-9.5	-9.5
	25	10.3	10.2	-9.5	-9.5
	26	10.0	10.1	-9.4	-9.5
	27	10.1	10.0	-9.6	-9.5
	28	9.7	9.9	-9.5	-9.5
	29	9.8	9.8	-9.5	-9.5
	30	9.8	9.6	-9.4	-9.5
					-9.5 Monthly Average
					.08 Noise, rms

TABLE 6

VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
July	1	9.4	9.6	-9.4	-9.5
	2	9.5	9.6	-9.5	-9.4
	3	9.6	9.7	-9.5	-9.4
	4	9.9	9.7	-9.4	-9.5
	5	10.2	9.5	-9.4	-9.5
	6	8.9	9.2	-9.6	-9.5
	7	8.8	8.9	-9.5	-9.5
	8	8.1	8.6	-9.4	-9.5
	9	8.5	8.6	-9.4	-9.5
	10	8.8	8.5	-9.6	-9.4
	11	8.6	8.5	-9.4	-9.5
	12	8.3	8.4	-9.4	-9.5
	13	8.4	8.3	-9.5	-9.5
	14	8.1	8.2	-9.6	-9.5
	15	8.1	8.1	-9.5	-9.5
	16	8.1	8.0	-9.5	-9.5
	17	7.8	7.9	-9.4	-9.5
	18	7.7	7.8	-9.5	-9.5
	19	7.8	7.7	-9.5	-9.5
	20	7.8	7.6	-9.5	-9.5
	21	7.3	7.5	-9.5	-9.5
	22	7.2	7.5	-9.5	-9.5
	23	7.6	6.9	-9.5	-9.5
	24	7.0	6.4	-9.4	-9.4
	25	5.2	6.1	-9.4	-9.4
	26	5.0	5.8	-9.4	-9.4
	27	5.9	5.8	-9.5	-9.4
	28	6.1	6.0	-9.5	-9.4
	29	6.7	6.2	-9.3	-9.4
	30	6.3	6.3	-9.4	-9.4
	31	6.0	6.1	-9.4	-9.3

-9.5 Monthly Average  
.10 Noise, rms

TABLE 7



VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
August	1	6.2	5.9	-9.3	-9.4
	2	5.4	5.9	-9.3	-9.3
	3	5.8	5.8	-9.4	-9.3
	4	--	5.6	--	-9.3
	5	--	5.4	--	-9.4
	6	--	5.0	--	-9.4
	7	5.1	4.8	-9.4	-9.4
	8	5.0	4.8	-9.4	-9.4
	9	4.3	4.7	-9.5	-9.4
	10	4.8	4.5	-9.5	-9.4
	11	4.5	4.3	-9.3	-9.4
	12	4.1	4.2	-9.3	-9.4
	13	3.8	4.1	-9.4	-9.3
	14	3.8	3.9	-9.3	-9.4
	15	4.2	3.8	-9.4	-9.4
	16	3.8	3.8	-9.4	-9.4
	17	3.6	3.6	-9.4	-9.4
	18	3.4	3.5	-9.3	-9.4
	19	3.1	3.2	-9.3	-9.4
	20	--	3.0	--	-9.4
	21	2.7	2.8	-9.4	-9.4
	22	2.8	2.6	-9.5	-9.4
	23	2.4	2.5	-9.5	-9.4
	24	2.6	2.4	-9.2	-9.4
	25	2.0	2.2	-9.4	-9.4
	26	--	2.0	--	-9.3
	27	1.9	1.7	-9.3	-9.4
	28	1.7	1.5	-9.4	-9.4
	29	1.3	1.4	-9.4	-9.3
	30	1.3	1.3	-9.3	-9.3
	31	1.1	1.1	-9.2	-9.3

-9.4 Monthly Average  
.09 Noise, rms

TABLE 8

## VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
September	1	0.9	0.9	-9.3	-9.2
	2	0.8	0.6	-9.2	-9.3
	3	0.4	0.5	-9.1	-9.3
	4	0.0	0.4	-9.6	-9.3
	5	0.6	0.4	-9.2	-9.3
	6	0.3	0.3	-9.3	-9.3
	7	0.5	0.2	-9.2	-9.3
	8	0.2	0.0	-9.3	-9.3
	9	-0.6	-0.1	-9.5	-9.3
	10	-0.3	-0.3	-9.3	-9.3
	11	-0.5	-0.5	-9.3	-9.4
	12	-0.3	-0.6	-9.3	-9.4
	13	-0.7	-0.7	-9.7	-9.4
	14	-1.0	-1.0	-9.3	-9.4
	15	-1.2	-1.4	-9.4	-9.4
	16	-1.9	-1.6	-9.3	-9.3
	17	-2.1	-1.6	-9.3	-9.4
	18	-2.1	-1.3	-9.4	-9.3
	19	-0.9	-0.9	-9.4	-9.3
	20	+0.3	-0.5	-9.3	-9.3
	21	+ .1	0.0	-9.2	-9.2
	22	.3	+0.2	-9.1	-9.2
	23	+ .3	+0.1	-9.1	-9.1
	24	--	-0.1	--	-9.2
	25	-0.4	-0.5	-9.2	-9.2
	26	-0.7	-1.0	-9.3	-9.3
	27	-1.1	-1.2	-9.5	-9.3
	28	-1.7	-1.4	-9.3	-9.3
	29	-1.9	-1.6	-9.4	-9.3
	30	-1.7	-1.8	-9.2	-9.3

-9.3 Monthly Average  
.14 Noise, rms

TABLE 9

VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
October	1	-1.7	-2.0	-9.3	-9.4
	2	-2.0	-2.1	-9.5	-9.4
	3	-2.7	-2.4	-9.4	-9.5
	4	-2.6	-2.9	-9.6	-9.5
	5	-3.2	-3.1	-9.6	-9.6
	6	-3.9	-3.2	-9.6	-9.6
	7	-3.3	-3.4	-9.8	-9.6
	8	-3.1	-3.4	-9.6	-9.6
	9	-3.3	-3.3	-9.5	-9.6
	10	-3.5	-3.3	-9.6	-9.5
	11	-3.3	-3.5	-9.6	-9.5
	12	-3.2	-3.7	-9.2	-9.6
	13	-4.1	-3.7	-9.8	-9.6
	14	-4.2	-3.9	-9.6	-9.6
	15	-3.9	-4.0	-9.6	-9.6
	16	-4.1	-4.0	-9.6	-9.5
	17	-3.9	-3.9	-9.4	-9.5
	18	-3.8	-3.9	-9.4	-9.4
	19	-4.0	-3.8	-9.4	-9.4
	20	-3.5	-3.7	-9.3	-9.4
	21	-3.6	-3.7	-9.4	-9.4
	22	-3.8	-3.5	-9.5	-9.4
	23	-3.5	-3.5	-9.3	-9.5
	24	-3.2	-3.5	-9.7	-9.5
	25	-3.4	-3.5	-9.6	-9.5
	26	-3.5	-3.8	-9.5	-9.5
	27	-3.7	-3.9	-9.2	-9.4
	28	-5.2	-3.9	-9.3	-9.3
	29	-3.6	-4.0	-9.2	-9.3
	30	-3.5	-3.6	-9.5	-9.4
	31	-3.9	-3.4	-9.1	-9.4
					-9.5 Monthly Average
					.18 Noise, rms

TABLE 10

## VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
November	1	-1.6	-3.3	-9.4	-9.4
	2	-4.2	-3.2	-9.4	-9.3
	3	-2.8	-3.2	-9.4	-9.4
	4	-3.3	-3.8	-9.4	-9.4
	5	-4.3	-3.3	-9.4	-9.4
	6	-4.3	-3.0	-9.3	-9.4
	7	-1.9	-2.3	-9.4	-9.3
	8	-1.3	-1.8	-9.3	-9.3
	9	+0.3	-1.6	-9.3	-9.4
	10	-2.0	-2.1	--	-9.4
	11	-3.2	-2.4	-9.5	-9.4
	12	-4.2	-3.3	-9.4	-9.4
	13	-3.0	-4.0	-9.4	-9.4
	14	-4.4	-3.8	-9.3	-9.4
	15	-5.0	-3.1	-9.4	-9.4
	16	-2.3	-3.0	-9.3	-9.4
	17	-0.9	-2.9	-9.5	-9.5
	18	-2.4	-2.9	-9.4	-9.5
	19	-3.7	-3.4	-9.7	-9.5
	20	-5.1	-3.6	-9.5	-9.5
	21	-5.2	-4.1	-9.5	-9.5
	22	-1.6	-4.4	-9.2	-9.4
	23	-4.8	-4.5	-9.4	-9.4
	24	-5.2	-4.7	-9.5	-9.3
	25	-5.6	-5.7	-9.3	-9.4
	26	-6.2	-5.6	-9.3	-9.4
	27	-6.9	-5.9	-9.3	-9.3
	28	-4.3	-6.0	-9.4	-9.3
	29	-6.3	-6.5	-9.4	-9.4
	30	-6.1	-7.0	-9.3	-9.4

-9.4 Monthly Average  
0.10 Noise, rms

TABLE 11

## VLF DATA (usec.)

1967 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average
December	1	-9.1	-7.7	-9.4	-9.4
	2	-9.0	-8.3	--	-9.4
	3	-7.9	-9.0	-9.7	-9.4
	4	-9.3	-9.0	-9.4	-9.4
	5	-9.7	-9.2	-9.5	-9.4
	6	-9.0	-9.6	-9.1	-9.3
	7	-10.0	-9.8	-9.3	-9.4
	8	-9.8	-10.1	-9.4	-9.4
	9	-10.4	-10.8	-9.5	-9.6
	10	-11.0	-11.2	-9.7	-9.7
	11	-12.7	-11.7	-10.0	-9.7
	12	-12.3	-11.9	-9.7	-9.8
	13	-12.3	-12.1	-9.8	-9.8
	14	-11.2	-12.0	-9.8	-9.7
	15	-11.9	-12.0	-9.7	-9.7
	16	-12.2	-12.2	-9.6	-9.6
	17	-12.4	-12.6	-9.5	-9.6
	18	-13.1	-13.1	-9.4	-9.6
	19	-13.3	-13.3	-9.6	-9.6
	20	-14.7	-13.6	-9.7	-9.7
	21	-13.2	-13.7	-9.9	-9.7
	22	-13.6	-14.0	-9.7	-9.8
	23	-14.1	-14.0	-9.8	-9.8
	24	-14.6	-14.3	-9.9	-9.7
	25	-14.6	-14.5	-9.6	-9.7
	26	-14.8	-14.5	-9.6	-9.6
	27	-14.2	-15.0	-9.5	-9.5
	28	-14.2	-15.8	-9.4	-9.5
	29	-17.4	-16.7	-9.5	-9.5
	30	-18.6	-17.1	-9.5	-9.5
	31	-19.0	-16.7	--	-9.5
					-9.6 Monthly Average
					0.20 Noise, rms

TABLE 12